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(54) **ANTI-MICROBIAL AIR PROCESSOR FOR A PERSONAL PATIENT WARMING APPARATUS**

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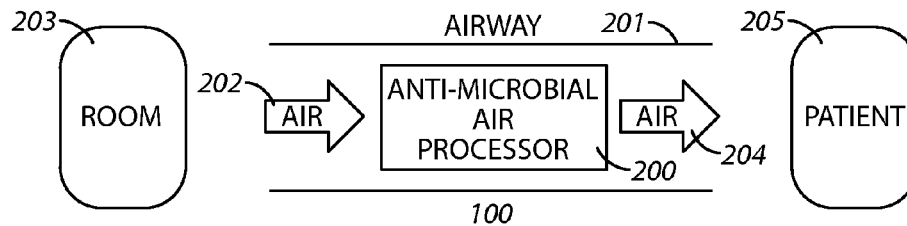
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(57) **ABSTRACT**

An anti-microbial air processor is configured and arranged to fit at least substantially across an airway in a personal patient-warming apparatus to thereby inactivate airborne microbes before those airborne microbes are exposed to a patient via warming air delivered by the personal patient-warming apparatus. By one approach, the anti-microbial air processor comprises an anti-microbial air filter. By another approach, in lieu of the foregoing or in combination therewith, the anti-microbial air processor comprises one or more ultraviolet light sources configured to expose at least one inner surface of the personal patient-warming apparatus to ultraviolet light to thereby inactivate microbes.

**17 Claims, 2 Drawing Sheets**



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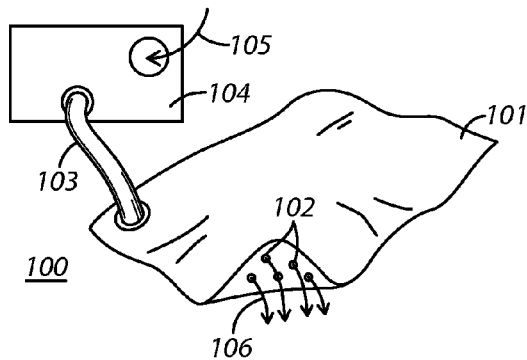
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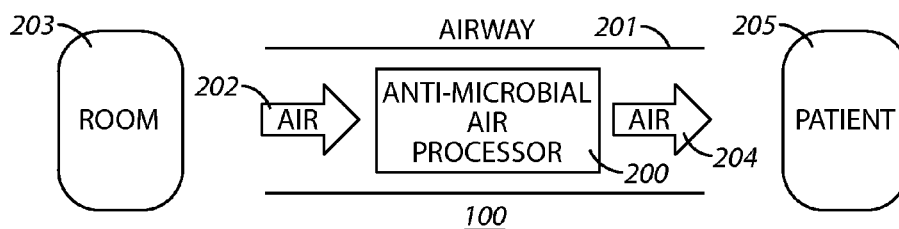
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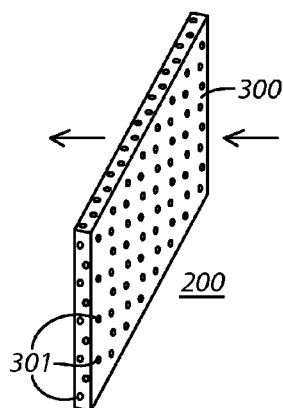
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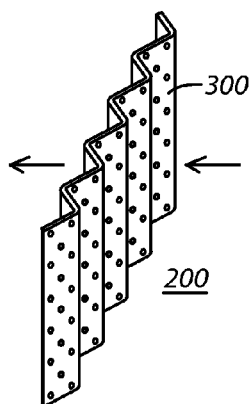
**FIG. 1**  
**PRIOR ART**



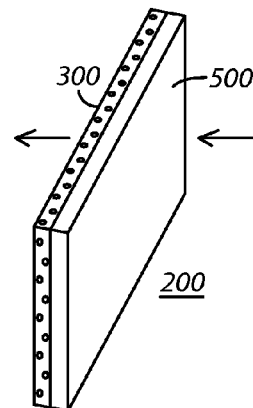
**FIG. 2**



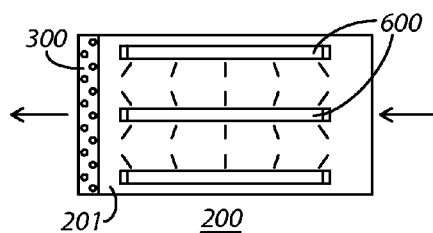
**FIG. 3**



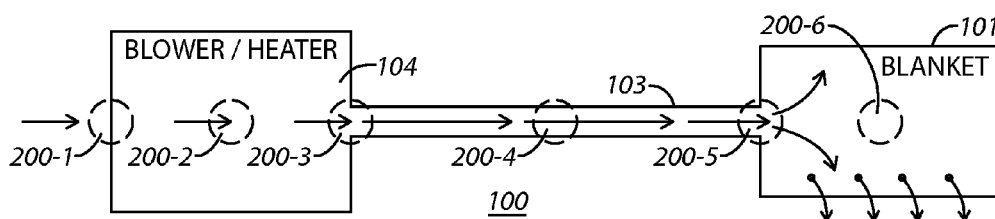
**FIG. 4**



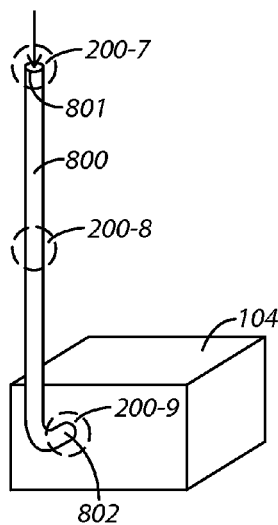
**FIG. 5**



**FIG. 6**



**FIG. 7**



**FIG. 8**

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# ANTI-MICROBIAL AIR PROCESSOR FOR A PERSONAL PATIENT WARMING APPARATUS

## TECHNICAL FIELD

This invention relates generally to personal patient warmers.

## BACKGROUND

Personal patient warming apparatuses are known in the art. Being "personal," these apparatuses do not serve in any meaningful way to warm a general area (such as a room). Instead, these apparatuses serve to provide local-to-a-patient warming for the benefit of an individual patient (typically during the administration of a medical-services procedure such as but not limited to an operation). While some of the delivered warmth will typically escape beyond the patient themselves, the focus of the warmth delivery mechanism is intended and designed to primarily warm the patient as versus the local environment.

One category of personal patient warming apparatuses serves to deliver warmed air to the patient. By one common approach, the personal patient warming apparatus includes a blanket that overlies the patient. This blanket includes one or more internal pneumatic chambers. A blower forces warmed air into the blanket and that warmed air then exits the blanket via a plurality of small orifices (typically located on an underside surface of the blanket). The exiting warmed air, in turn, provides local warming in very close proximity to the patient.

While such an approach can serve very well to warm a patient in a highly localized and controlled manner, there is the potential for such an approach to introduce new complications as well. For example, the warmed air directed to the patient may include potentially harmful microbes. The sources of such microbes are many and varied. Some operating rooms, for example, use a top-to-bottom air flow ventilation system. In such a case the most contaminated air in the room will typically be near the floor. Unfortunately, the air-intake for the heater/blower of the personal patient warming apparatus may also be located near the floor, hence encouraging the intake of contaminated air. In other cases, and as another example, the microbes may be growing with the pneumatic pathways of the heater/blower itself.

Many personal patient warming apparatuses include a particulate filter (not to be confused with a HEPA filter). While suitable to block larger particles such as certain dust particles, such a filter will not ordinarily block the passage of microbes. Accordingly, if potentially-harmful microbes are present, the usual filters employed in available personal patient warming apparatuses are largely ineffectual to keep those microbes separated from the patient. Exposure to microbes, in turn, carries with it a risk of infection and attending complications.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above needs are at least partially met through provision of the an anti-microbial air processor for a personal patient-warming apparatus described in the following detailed description, particularly when studied in conjunction with the drawings, wherein:

FIG. 1 comprises a schematic view as configured in accordance with the prior art;

FIG. 2 comprises a side elevational schematic view as configured in accordance with various embodiments of the invention;

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FIG. 3 comprises a perspective view as configured in accordance with various embodiments of the invention;

FIG. 4 comprises a perspective view as configured in accordance with various embodiments of the invention;

5 FIG. 5 comprises a perspective view as configured in accordance with various embodiments of the invention;

FIG. 6 comprises a side elevational sectioned schematic view as configured in accordance with various embodiments of the invention;

10 FIG. 7 comprises a side elevational schematic view as configured in accordance with various embodiments of the invention; and

FIG. 8 comprises a perspective schematic view as configured in accordance with various embodiments of the invention.

15 Elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions and/or relative positioning of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of various embodiments of the present invention. Also, common but well-understood elements that are useful or necessary in a commercially feasible embodiment are often not depicted in order to facilitate a less obstructed view of these various embodiments of the present invention. Certain actions and/or steps may be described or depicted in a particular order of occurrence while those skilled in the art will understand that such specificity with respect to sequence is not actually required. The terms and expressions used herein have the ordinary technical meaning as is accorded to such terms and expressions by persons skilled in the technical field as set forth above except where different specific meanings have otherwise been set forth herein.

## DETAILED DESCRIPTION

Generally speaking, pursuant to these various embodiments an anti-microbial air processor is configured and arranged to fit at least substantially across an airway in a personal patient-warming apparatus to thereby inactivate airborne microbes before those airborne microbes are exposed to a patient via warming air delivered by the personal patient-warming apparatus. By one approach, the anti-microbial air processor comprises an anti-microbial air filter. By another approach, in lieu of the foregoing or in combination therewith, the anti-microbial air processor comprises one or more ultraviolet light sources configured to expose at least one inner surface of the personal patient-warming apparatus to ultraviolet light to thereby inactivate microbes.

50 These teachings are highly flexible in practice and will accommodate a wide variety of modifications and adaptations. The anti-microbial air processor can be located, for example, at any one or more of a variety of locations including but not limited to the intake for the heater/blower, the outtake for the heater/blower, within a warm air delivery tube as comprises an external part of the personal patient-warming apparatus, or even as a part of the pneumatic warming blanket that serves to ultimately bath the patient in the expelled warmed air.

60 So configured, such an anti-microbial air processor can contribute to at least a significant reduction in the number of active microbes that reach the patient via warmed air. The present teachings can be economically deployed and can also (at least in many cases) be applied retroactively for use with already-fielded personal patient warming apparatuses.

These and other benefits may become clearer upon making a thorough review and study of the following detailed descrip-

tion. Referring now to the drawings, and in particular to FIG. 1, it may be helpful to first briefly recount a simple illustrative example of a personal patient warming apparatus **100** that delivers warmed air to a patient. In this example, the personal patient warming apparatus **100** includes a pneumatic blanket **101** having one or more pneumatic chambers formed therein and a plurality of small orifices **102** formed through the blanket material by which warmed air can escape from the aforementioned chamber(s).

A warm air delivery tube **103** couples the blanket's pneumatic chamber(s) to a heater/blower **104**. The heater/blower **104** pulls in ambient air **105** through one or more intake ports using one or more fans or other air-moving mechanisms, warms that air using a heating methodology of choice, and pushes that warmed air out to the blanket **101** via the warm air delivery tube **103**. That warmed air **106** then eventually exits the blanket **101** via the aforementioned orifices **102**. When the blanket **101** overlies a patient that exiting warmed air **106** serves to provide localized warming for the patient.

Those skilled in the art will recognize that the prior art accommodates a wide number of variations as regards the foregoing. The specific construction and form factor of the blanket **101**, for example, can vary considerably from one embodiment to another. As another example, there are all manner of approaches to heating the air and causing the air to move that are available for consideration. As the present teachings are not particularly sensitive to any particular selections in these regards, however, for the sake of brevity further elaboration in these regards will not be provided here aside from noting that the expression "personal patient warming apparatus" as used herein will be understood to include both the embodiment illustrated in FIG. 1 and other such variations as are reasonably associated therewith.

Referring now to FIG. 2, the present teachings provide for fitting at least one anti-microbial air processor **200** across an airway **201** of a personal patient warming apparatus **100**. In particular, by one approach the anti-microbial air processor **200** is configured and arranged to fit at least substantially across the airway **201** of choice. So located, the anti-microbial air processor **200** receives incoming (upstream) air **202** (as drawn, for example, from a room **203** that contains the patient **205**) and passes air **204** downstream to the patient **205**.

Being an "anti-microbial" air processor **200**, this air processor may or may not impede the flow of particles of one size or another but does in any event serve the purpose of inactivating at least a substantial number of microbes as pass therethrough. For example, by one approach such an anti-microbial air processor **200** may inactivate at least fifty percent of all microbes that pass therethrough. By another approach such an anti-microbial air processor **200** may inactivate at least seventy-five percent of all microbes that pass therethrough. And by yet another approach such an anti-microbial air processor **200** may inactivate at least ninety percent of all microbes that pass therethrough.

These teachings will accommodate a variety of different anti-microbial air processors **200**. With reference to FIG. 3, by one approach the anti-microbial air processor **200** can comprise, at least in part, an anti-microbial air filter. This anti-microbial air filter can comprise, for example, at least one active layer of filter material **300**. This active layer of filter material **300** can itself comprise, by one approach, a fabric substrate having a plurality of positively-charged ions **301** disposed therein. By one approach, and as an illustrative example, the fabric substrate could comprise a splunlace fabric from cellulosic (such as Rayon) fibers.

These positively-charged ions **301** can comprise, for example, copper ions, zinc ions, or silver ions, to note but a

few examples in these regards, either alone or in any of a variety of combinations with one another. For example, by one approach the filter material **300** can comprise a fabric substrate having both copper ions and zinc ions disposed therein. When using a combination of ions the ratio of one type of ion to the other can vary as desired. By one approach, for example, there can be a more-or-less equal amount of copper ions as compared to zinc ions.

Such ions are positively-charged ions. In the described application setting these positively-charged ions will bind with negatively-charged groups that are present on at least some microbes. When this binding occurs the corresponding microbe is inactivated (that is, the microbe's biological ability to function in a harmful way on or in a human host is disabled).

In the illustrative example of FIG. 3 the filter material **300** comprises a block of the desired material. If desired, and as illustrated in FIG. 4, the fabric substrate that comprises the filter material **300** can be pleated (as densely or as loosely packed as desired) to thereby form a longer filter pathway. These teachings will also accommodate combining pleated sheets with unpleated sheets to form multiple stages of such material.

Or, and referring now to FIG. 5, the aforementioned filter material **300** can be combined with at least a second active layer of filter material **500** that is different than the first active layer of filter material **300**. For example, by one approach, the second active layer of filter material **500** can offer a low pH environment (created, by way of example and at least in part, by the use of citric acid) that serves as a different modality of anti-microbial agent to thereby inactivate microbes using an alternative approach. By one approach, and as illustrated, the two layers of filter materials **300** and **500** can be juxtaposed immediately adjacent one another (and held in combination with one another using an adhesive or other attachment mechanism of choice if desired) with the second active layer of filter material **500** being disposed upstream of the first active layer of filter material **300**.

Also if desired, this second active layer of filter material **500** can have a hydrophilic coating (such coatings being known in the art) on a spunbond fabric comprised of polypropylene to thereby attract water-borne microbes to the surfaces of one or both layers of filter material.

If desired, in combination with the above or in lieu thereof, other anti-microbial materials can serve in these same regards. As one illustrative example in these regards, the anti-microbial air filter can comprise a serpentine pneumatic pathway formed at least in part of Microban plastics (or the like) that include anti-bacterial additives to inactivate microbes on contact. So configured, and depending upon the length of the serpentine pneumatic pathway and the number and shape of the pathway contortions, at least many airborne microbes will contact a wall of the serpentine pathway while making the transit from an input to an output and become inactivated as a result of that contact.

As another example in these regards, and referring now to FIG. 6, by one approach the anti-microbial air processor **200** can include (alone or in combination with other anti-microbial agents such as the aforementioned anti-microbial air filter) one or more ultraviolet light sources **600** that are again disposed with respect to an airway **201** of choice as corresponds to the personal patient warming apparatus to expose at least one inner surface of the personal patient warming apparatus to short-wave germicidal ultraviolet light (sometimes denoted in the art as UV-C) to thereby again inactivate microbes.

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Generally speaking, and referring now to FIG. 7, the present teachings are highly flexible as regards the placement of the anti-microbial air processor 200 with respect to the portable patient warming apparatus 100. Examples include:

- at the air intake port of the heater/blower 104 (as denoted by reference numeral 200-1);
- internal to the heater/blower 104 (as denoted by reference numeral 200-2);
- at the air output port of the heater/blower 104 and/or at the input of the warm air delivery tube 103 (as denoted by reference numeral 200-3);
- within the warm air delivery tube 103 (as denoted by reference numeral 200-4);
- at the output of the warm air delivery tube 103 and/or at the input to the pneumatic blanket 101 (as denoted by reference numeral 200-5); and/or
- within the pneumatic blanket 101 (where, for example, all or part of the internal surfaces of the pneumatic blanket air chamber are faced with an anti-microbial material of choice) (as denoted by reference numeral 200-6).

When the anti-microbial air processor 200 comprises an anti-microbial air filter, the filter can be configured as a replaceable part or can be configured as an integral part of the corresponding component. For example, when the anti-microbial air filter is used in conjunction with the heater/blower 104 it can be useful, convenient, and economical to configure the anti-microbial air filter as a replaceable component. As another example, when the anti-microbial air filter is used in conjunction with the pneumatic blanket 101, it may be more appropriate to configure the filter as an integral part of the blanket 101 that is disposed of following a one-time use of the blanket 101.

By way of yet another example, and referring now to FIG. 8, these teachings will accommodate using a snorkel 800 having an air-intake port 801 that is disposed at least one meter above the heater/blower intake port and an air-output port 802 that is pneumatically coupled to the heater/blower intake port. The point of such an arrangement is to arrange for the heater/blower 104 to utilize air that is higher in the room and hence less contaminated (at least in many cases) than the air that is lower in the room. In such a case the anti-microbial air processor 200 can be located at the air intake port 801 of the snorkel 800 as denoted by reference numeral 200-7, somewhere along the length of the snorkel 800 as denoted by reference numeral 200-8, and/or at the air-output port 802 of the snorkel 800 as denoted by reference numeral 200-9.

So configured, warmed air that a personal patient warming apparatus delivers to a patient can be significantly cleansed of active microbes. That reduction in the number of active microbes, in turn, can help to avoid infections and other problems that might otherwise be experienced by the patient. In many cases these teachings can be implemented in cost-effective ways and can be maintained and used without significant training requirements.

Those skilled in the art will recognize that a wide variety of modifications, alterations, and combinations can be made with respect to the above described embodiments without departing from the scope of the invention, and that such modifications, alterations, and combinations are to be viewed as being within the ambit of the inventive concept.

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What is claimed is:

1. An apparatus comprising:

an anti-microbial air processor configured and arranged to fit at least substantially across an airway in a personal patient-warming apparatus to thereby inactivate airborne microbes before those airborne microbes are exposed to a patient via warming air delivered by the personal patient-warming apparatus wherein the anti-microbial air processor is disposed in

a pneumatic warming blanket that comprises a part of the personal patient-warming apparatus.

2. The apparatus of claim 1 wherein the anti-microbial air processor comprises, at least in part, an anti-microbial air filter.

3. The apparatus of claim 2 wherein the anti-microbial air filter includes at least one active layer of filter material.

4. The apparatus of claim 3 wherein the active layer of filter material includes positively-charged ions that bind with negatively-charged groups present on at least some microbes to thereby inactivate the microbes.

5. The apparatus of claim 4 wherein the positively-charged ions include at least one of copper ions, zinc ions, and silver ions.

6. The apparatus of claim 5 wherein the positively-charged ions include both of copper ions and zinc ions.

7. The apparatus of claim 6 wherein the copper and zinc ions are disposed within a fabric substrate.

8. The apparatus of claim 7 wherein the fabric substrate is pleated to form a longer filter pathway.

9. The apparatus of claim 3 wherein the anti-microbial air filter includes at least a second active layer of filter material.

10. The apparatus of claim 9 wherein the second active layer of filter material has a hydrophilic coating.

11. The apparatus of claim 10 wherein the second active layer of filter material has a low pH environment to thereby inactivate microbes.

12. The apparatus of claim 11 wherein the low pH environment is created, at least in part, by citric acid.

13. The apparatus of claim 9 wherein the second active layer of filter material is disposed upstream of the first active layer of filter material.

14. The apparatus of claim 1 wherein the anti-microbial air processor further includes a component that is disposed at an intake for a blower.

15. The apparatus of claim 1 wherein the anti-microbial air processor further includes a component that is disposed at an output port for a blower.

16. The apparatus of claim 1 wherein the anti-microbial air processor comprises, at least in part, an ultraviolet light source configured to expose at least one inner surface of the personal patient-warming apparatus to ultraviolet light to thereby inactivate microbes.

17. The apparatus of claim 1 further comprising:

an air-intake snorkel having an air-intake port disposed at least one meter above a blower intake for the personal patient-warming apparatus and an air-output port pneumatically coupled to a blower intake.

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